

CLAIMS

1. A centerless grinder for grinding a workpiece comprising:

a grinding wheel having a working surface with a plurality of raised areas extending circumferentially around at least a portion of the working surface;

a platform having an elongated top surface for supporting the workpiece substantially adjacent to the working surface and a front surface with a plurality of lateral grooves for receiving the raised areas on the working surface such that movement of the platform toward the working surface into a working area adjacent the grinding wheel enables the raised areas to pass into the lateral grooves and grind the workpiece.

2. A centerless grinder as in claim 1, wherein the platform comprises an elongated groove forming a shelf along the intersection of the front surface and the top surface and the workpiece is supported within the elongated groove.

3. A centerless grinder as in claim 2, wherein the elongated groove is generally L-shaped.

4. A centerless grinder as in claim 2, wherein the lateral grooves are substantially parallel to each other, are spaced substantially equally distant from one another and extend from the bottom of the elongated groove down the front surface.

5. A centerless grinder as in claim 4, wherein the depth of the lateral grooves along the bottom of the elongated groove tapers from a greater depth at one end of the elongated groove to a lesser depth at the other end of the elongated groove.

6. A centerless grinder as in claim 5, wherein the height of the raised areas on the working surface taper

from a greater height at the one end of the elongated groove to a lesser height at the other end of the elongated groove such that the distance between the raised areas and the back of the elongated groove, when the raised areas are within the lateral grooves, tapers from a lesser distance at the one end to a greater distance at the other end.

7. A centerless grinder as in claim 3, wherein movement of the platform toward the working surface enables the raised areas to press the workpiece into the corner of the generally L-shaped groove.

8. A centerless grinder as in claim 3, wherein the bottom of the generally L-shaped groove slopes upwardly at a slight angle in the direction of the grinding wheel to urge the workpiece toward the corner of the generally L-shaped groove.

9. A centerless grinder as in claim 1, wherein the platform generally has the shape of a thin rectangular parallelepiped with the top surface being one of the long edges of the parallelepiped and the front surface being one of the faces of the parallelepiped.

10. A centerless grinder as in claim 9, wherein the parallelepiped comprises an elongated generally L-shaped groove formed along the intersection of the front surface and the top surface and the workpiece is supported within the generally L-shaped groove.

11. A centerless grinder as in claim 4, wherein the raised areas are substantially parallel to each other, are spaced substantially equally distant from one another and extend around the entire circumference of the working surface.

12. A centerless grinder as in claim 1, wherein the platform is fabricated from a carbide material.

13. A centerless grinder as in claim 1, wherein the platform is fabricated from a plastic material.

14. A centerless grinder as in claim 1, wherein the platform is fabricated from a material selected from the group consisting of heat-treated steel, tool steel, polycrystalline diamond, a ceramic, teflon, and nylon.

15. A centerless grinder as in claim 1, further comprising a feed screw and a servomotor for moving the platform toward and away from the working surface.

16. A centerless grinder as in claim 1, further comprising a first spindle and collet positioned in front of the working area for rotating the workpiece and moving the workpiece one or both of forwardly and backwardly through the working area.

17. A centerless grinder as in claim 16, further comprising a pivot, and wherein the first spindle and collet is coupled to the platform through the pivot to maintain alignment of the first spindle and collet with the platform during the movement of the platform toward the working surface.

18. A centerless grinder as in claim 16, further comprising a second spindle and collect positioned behind the working area for rotating the workpiece and moving the workpiece one or both of forwardly and backwardly through the working area.

19. A centerless grinder as in claim 18, further comprising a pivot, and wherein the second spindle and collet is coupled to the platform through the pivot to maintain alignment of the second spindle and collet with the platform during the movement of the platform toward the working surface.

20. A centerless grinder as in claim 1, further comprising a spool for holding wire stock, pinch rollers

positioned in front of the working area for gripping the wire stock and pulling a length of the wire stock from the spool and a cutter positioned in front of the working area for cutting the length of wire stock to provide the workpiece.

21. A centerless grinder for grinding a workpiece comprising:

a grinding wheel having a working surface with a plurality of raised areas extending circumferentially around at least a portion of the working surface;

a platform for supporting the workpiece substantially adjacent to the working surface, the platform having a top surface and a front surface with an elongated groove forming a shelf along the intersection of the front surface and the top surface, the workpiece being supported within the elongated groove, the platform further having a plurality of lateral grooves extending from the bottom of the elongated groove down the front surface for receiving the raised areas on the working surface such that movement of the platform toward the working surface into a working area adjacent the grinding wheel enables the raised areas to pass into the lateral grooves and grind the workpiece.

22. A centerless grinder as in claim 21, wherein the elongated groove is generally L-shaped and the lateral grooves are substantially parallel to each other and spaced substantially equally distant from one another.

23. A centerless grinder as in claim 21, wherein the depth of the lateral grooves along the bottom of the elongated groove tapers from a greater depth at one end of the elongated groove to a lesser depth at the other end of the elongated groove.

24. A centerless grinder as in claim 23, wherein the height of the raised areas on the working surface taper

from a greater height at the one end of the elongated groove to a lesser height at the other end of the elongated groove such that the distance between the raised areas and the back of the elongated groove, when the raised areas are within the lateral grooves, tapers from a lesser distance at the one end to a greater distance at the other end.

25. A centerless grinder as in claim 21, wherein movement of the platform toward the working surface enables the raised areas to press the workpiece into the elongated groove.

26. A centerless grinder as in claim 21, wherein the platform generally has the shape of a thin rectangular parallelepiped with the top surface being one of the long edges of the parallelepiped and the front surface being one of the faces of the parallelepiped.

27. A centerless grinder as in claim 21, wherein the raised areas are substantially parallel to each other, are spaced substantially equally distant from one another and extend around the entire circumference of the working surface.

28. A centerless grinder as in claim 21, wherein the platform is fabricated from a carbide material.

29. A centerless grinder as in claim 21, wherein the platform is fabricated from a plastic material.

30. A centerless grinder as in claim 21, wherein the platform is fabricated from a material selected from the group consisting of heat-treated steel, tool steel, polycrystalline diamond, a ceramic, teflon, and nylon.

31. A centerless grinder as in claim 21, further comprising a feed screw and a servomotor for moving the platform toward and away from the working surface.

32. A centerless grinder as in claim 21, further comprising a first spindle and collet positioned in front of

the working area for rotating the workpiece and moving the workpiece one or both of forwardly and backwardly through the working area.

33. A centerless grinder as in claim 32, further comprising a pivot, and wherein the first spindle and collet is coupled to the platform through the pivot to maintain alignment of the first spindle and collet with the platform during the movement of the platform toward the working surface.

34. A centerless grinder as in claim 32, further comprising a second spindle and collet positioned behind the working area for rotating the workpiece and moving the workpiece one or both of forwardly and backwardly through the working area.

35. A centerless grinder as in claim 34, further comprising a pivot, and wherein the second spindle and collet is coupled to the platform through the pivot to maintain alignment of the second spindle and collet with the platform during the movement of the platform toward the working surface.

36. A centerless grinder as in claim 21, further comprising a spool for holding wire stock, pinch rollers positioned in front of the working area for gripping the wire stock and pulling a length of the wire stock from the spool and a cutter positioned in front of the working area for cutting the length of wire stock to provide the workpiece.

37. A centerless grinder for grinding a workpiece comprising:

a grinding wheel;

first means for supporting the workpiece and moving the workpiece laterally toward the grinding wheel

into a working area adjacent the grinding wheel for grinding the workpiece;

second means for moving the workpiece one or both of forwardly and backwardly through the working area;

third means for rotating the workpiece in the working area;

a spool for holding wire stock;

fourth means for dispensing a length of the wire stock from the spool;

fifth means for cutting the length of wire stock to provide the workpiece; and

a guide for receiving the length of wire stock from the spool, directing the length of wire stock to the fifth means, and directing the workpiece from the fifth means toward the working area.

38. A centerless grinder as in claim 37, wherein the first and second means comprise a work rest blade and a regulating wheel and further comprising a feed screw and servomotor for moving the regulating wheel toward and away from the work rest blade.

39. A centerless grinder as in claim 37, wherein the grinding wheel has a working surface with a plurality of raised areas extending circumferentially around at least a portion of the working surface, and the first means comprises a platform having an elongated top surface for supporting the workpiece substantially adjacent to the working surface and a front surface with a plurality of lateral grooves for receiving the raised areas on the working surface such that movement of the platform toward the working surface enables the raised areas to pass into the lateral grooves and grind the workpiece.

40. A centerless grinder as in claim 39, further comprising a feed screw and servomotor for moving the

platform toward the working surface and away from the working surface.

41. A centerless grinder as in claim 37, wherein the first means comprises an elongated bushing having a slot for receiving the grinding wheel.

42. A centerless grinder as in claim 41, further comprising a feed screw and servomotor for moving the elongated bushing toward the working surface and away from the working surface.

43. A centerless grinder as in claim 37, wherein the second and third means comprise a first spindle and collet.

44. A centerless grinder as in claim 43, wherein the second and third means further comprise a motor for spinning the first spindle and collet and a feed screw and servomotor for moving the first spindle and collet one or both toward the working area and away from the working area.

45. A centerless grinder as in claim 43, further comprising a second spindle and collet positioned behind the working area for rotating the workpiece and moving the workpiece one or both of toward the working area and away from the working area.

46. A centerless grinder as in claim 45, further comprising a motor for spinning the second spindle and collet and a feed screw and servomotor for moving the second spindle and collet one or both of toward the working area and away from the working area.

47. A centerless grinder as in claim 37, wherein the fourth means comprises pinch rollers through which the length of wire stock is passed and a motor for rotating the pinch rollers.

48. A centerless grinder as in claim 37, wherein the fourth means comprises indexing grippers through which the length of wire stock is passed.

49. A centerless grinder as in claim 47, wherein the guide comprises a first structure positioned between the pinch rollers and the spool having a first passageway for receiving the wire stock and guiding the wire stock through the pinch rollers.

50. A centerless grinder as in claim 49, wherein the guide further comprises a second structure positioned between the pinch rollers and the working area having a second passageway for receiving the wire stock and guiding the wire stock toward the working area.

51. A centerless grinder as in claim 50, wherein the guide further comprises a third structure positioned between the pinch rollers and the second structure having a third passageway for receiving the wire stock from the pinch rollers and guiding wire stock toward the second passageway.

52. A centerless grinder as in claim 50, wherein the fifth means comprises a knife blade and wherein the knife blade is positioned adjacent the outlet of the second passageway.

53. A centerless grinder as in claim 37, wherein the fifth means comprises a knife blade.

54. A centerless grinder as in claim 37, wherein the fifth means comprises an abrasive cutting wheel.

55. A centerless grinder as in claim 37, wherein the fifth means comprises a laser.

56. A centerless grinder as in claim 37, wherein the fifth means comprises electric discharge machining.

57. A centerless grinder as in claim 37, wherein the fifth means comprises a waterjet.

58. A centerless grinder for grinding a workpiece comprising:

a grinding wheel;

a support for holding the workpiece and moving the workpiece laterally toward the grinding wheel into a working area adjacent the grinding wheel for grinding the workpiece;

a first spindle and collet positioned in front of the working area for rotating the workpiece and for moving the workpiece one or both of forwardly and backwardly through the working area;

a spool for holding wire stock;

a gripper for pulling a length of the wire stock from the spool and transmitting the length of wire stock through the first spindle and collet;

a cutter for cutting the length of wire stock to provide the workpiece.

59. A centerless grinder as in claim 58, further comprising a guide for guiding the length of wire stock from the spool through the first spindle and collet.

60. A centerless grinder as in claim 58, further comprising a first pivot, and wherein the first spindle and collet is coupled to the support through the pivot to maintain alignment of the first spindle and collet with the support during the moving of the workpiece laterally toward the grinding wheel.

61. A centerless grinder as in claim 58, wherein the gripper comprises pinch rollers.

62. A centerless grinder as in claim 58, wherein the gripper comprises an indexing gripper.

63. A centerless grinder as in claim 58, wherein the grinding wheel comprises a working surface with a plurality of raised areas extending circumferentially around at least a portion of the working surface, and the support

comprises a platform having an elongated top surface for supporting the workpiece substantially adjacent to the working surface and a front surface with a plurality of lateral grooves for receiving the raised areas on the working surface such that movement of the platform toward the working surface into a working area adjacent the grinding wheel enables the raised areas to pass into the lateral grooves and grind the workpiece.

64. A centerless grinder as in claim 58, wherein the support comprises an elongated bushing having a slot for receiving the grinding wheel.

65. A centerless grinder as in claim 58, further comprising a feed screw and servomotor for moving the support toward the working surface and away from the working surface.

66. A centerless grinder as in claim 58, further comprising a motor for spinning the first spindle and collet and a feed screw and servomotor for moving the first spindle and collet one or both of toward the working area and away from the working area.

67. A centerless grinder as in claim 66, further comprising a second spindle and collet positioned behind the working area for rotating the workpiece and moving the workpiece one or both of toward the working area and away from the working area.

68. A centerless grinder as in claim 67, further comprising a motor for spinning the second spindle and collet and a feed screw and servomotor for moving the second spindle and collet one or both of toward the working area and away from the working area.

69. A centerless grinder as in claim 61, further comprising a motor for rotating the pinch rollers.

70. A centerless grinder as in claim 62, further comprising a pneumatic actuator for actuating the indexing gripper.

71. A centerless grinder as in claim 61, further comprising a first structure positioned between the pinch rollers and the spool having a first passageway for receiving the wire stock and guiding the wire stock through the pinch rollers.

72. A centerless grinder as in claim 71, further comprising a second structure positioned between the pinch rollers and the working area having a second passageway for receiving the wire stock and guiding the wire stock through the first spindle and collet.

73. A centerless grinder as in claim 72, further comprising a third structure positioned between the pinch rollers and the second structure having a third passageway for receiving the wire stock from the pinch rollers and guiding the wire stock toward the second passageway.

74. A centerless grinder as in claim 72, wherein the cutter comprises a knife blade positioned adjacent the outlet of the second passageway.

75. A centerless grinder for grinding a workpiece comprising:

a grinding wheel;

a work rest blade for supporting the workpiece adjacent the grinding wheel;

a regulating wheel positioned adjacent the grinding wheel for rotating the workpiece and moving the workpiece through a working area adjacent the grinding wheel;

a spool for holding wire stock;

a gripper for pulling a length of the wire stock from the spool;

a cutter for cutting the length of wire stock to provide the workpiece; and

a guide for receiving the length of wire stock from the spool, directing the length of wire stock to the cutter, and directing the workpiece from the cutter toward the working area.

76. A centerless grinder as in claim 75, wherein the gripper comprises a first set of pinch rollers.

77. A centerless grinder as in claim 75, wherein the gripper comprises an indexing gripper.

78. A centerless grinder as in claim 76, further comprising a second set of pinch rollers positioned in front of the working area for moving the workpiece into the working area.

79. A centerless grinder as in claim 78, further comprising a third set of pinch rollers positioned behind the working area for receiving the workpiece from the working area and removing the workpiece from the working area.

80. A centerless grinder as in claim 76, wherein the guide comprises a first structure positioned between the first set of pinch rollers and the spool having a first passageway for receiving the wire stock and guiding the wire stock through the first set of pinch rollers.

81. A centerless grinder as in claim 80, wherein the guide further comprises a second structure positioned between the first set of pinch rollers and the working area having a second passageway for receiving the wire stock and guiding the wire stock toward the working area.

82. A centerless grinder as in claim 81, wherein the guide further comprises a third structure positioned between the first set of pinch rollers and the second structure having a third passageway for receiving the wire

stock from the pinch rollers and guiding the wire stock toward the second passageway.

83. A centerless grinder as in claim 81, wherein the cutter comprises a knife blade positioned adjacent the outlet of the second passageway.

84. A centerless grinder as in claim 75, wherein the cutter comprises a knife blade.

85. A centerless grinder as in claim 75, wherein the cutter comprises an abrasive cutting wheel.

86. A centerless grinder as in claim 75, wherein the cutter comprises a laser.

87. A centerless grinder as in claim 75, wherein the cutter comprises electric discharge machining.

88. A centerless grinder as in claim 75, wherein the cutter comprises a waterjet.

89. A method of grinding an elongated workpiece using a centerless grinder, the centerless grinder comprising a grinding wheel, a support for holding the workpiece and moving the workpiece laterally toward the grinding wheel into a working area adjacent the grinding wheel for grinding the workpiece, a spindle and collet positioned in front of the working area for rotating the workpiece and moving the workpiece one or both of forwardly and backwardly through the working area, a spool for holding wire stock and a guide, said method comprising:

moving the spindle and collet backwardly away from the working area;

dispensing a length of the wire stock from the spool into the guide and from the guide through the spindle and collet;

closing the collet to grip the wire stock;

cutting the wire stock to provide the workpiece;

and

moving the spindle and collet one or both of toward the working area and away from the working area, while rotating the spindle and collet, to grind the workpiece.

90. A method as in claim 89, further comprising moving the spindle and collet forwardly toward the working area before cutting the wire stock to dispense a further length of the wire stock from the spool for the workpiece.

91. A method as in claim 89, wherein the centerless grinder further comprises pinch rollers for pulling the wire stock from the spool, and wherein the dispensing comprises rotating the pinch rollers to dispense the length of wire stock.

92. A method as in claim 91, further comprising opening the pinch rollers and moving the spindle and collet forwardly to dispense a further length of the wire stock for the workpiece before cutting the wire stock.

93. A method as in claim 92, further comprising closing the pinch rollers before cutting the wire stock to provide the workpiece.

94. A centerless grinder for grinding a workpiece comprising:

- a grinding wheel;

- a support for holding the workpiece and moving the workpiece laterally toward the grinding wheel into a working area adjacent the grinding wheel for grinding the workpiece;

- a first spindle and collet positioned in front of the working area for rotating the workpiece and moving the workpiece one or both of forwardly and backwardly through the working area;

- a second spindle and collet positioned behind the working area for rotating the workpiece and moving the

workpiece one or both of forwardly and backwardly through the working area.

95. A centerless grinder as in claim 94, further comprising a first pivot and a second pivot, and wherein the first spindle and collet is coupled to the support through the first pivot to maintain alignment of the first spindle and collet with the support during the moving of the workpiece laterally toward the grinding wheel and the second spindle and collet is coupled to the support through the second pivot to maintain alignment of the second spindle and collet with the support during the moving of the workpiece laterally toward the grinding wheel.

96. A centerless grinder as in claim 94, wherein the grinding wheel has a working surface with a plurality of raised areas extending circumferentially around at least a portion of the working surface, and the support comprises a platform having an elongated top surface for supporting the workpiece substantially adjacent to the working surface and a front surface with a plurality of lateral grooves for receiving the raised areas on the working surface such that movement of the platform toward the working surface enables the raised areas to pass into the lateral grooves and grind the workpiece.

97. A centerless grinder as in claim 96, further comprising a feed screw and servomotor for moving the platform one or both of toward the working surface and away from the working surface.

98. A centerless grinder as in claim 94, wherein the support comprises an elongated bushing having a slot for receiving the grinding wheel.

99. A centerless grinder as in claim 98, further comprising a feed screw and servomotor for moving the

elongated bushing one or both of toward the grinding wheel and away from the grinding wheel.

100. A centerless grinder as in claim 94, wherein the first spindle and collet comprise a motor for spinning the first spindle and collet and a feed screw and servomotor for moving the first spindle and collet one or both of toward the working area and away from the working area.

101. A centerless grinder as in claim 100, wherein the second spindle and collet comprise a motor for spinning the second spindle and collet and a feed screw and servomotor for moving the second spindle and collet one or both of toward the working area and away from the working area.

102. A centerless grinder as in claim 94, further comprising a first linear actuator for moving the first spindle and collet one or both of toward the working area and away from the working area.

103. A centerless grinder as in claim 102, further comprising a second linear actuator for moving the second spindle and collet one or both of toward the working area and away from the working area.

104. A centerless grinder as in claim 94, further comprising a spool for holding wire stock, a gripper positioned in front of the working area for gripping the wire stock and dispensing a length of the wire stock from the spool through the first spindle and collet and a cutter for cutting the length of wire stock to provide the workpiece.

105. A centerless grinder for grinding a workpiece comprising:

a grinding wheel having a working surface with a plurality of raised areas extending circumferentially around at least a portion of the working surface;

a platform having an elongated top surface for supporting the workpiece substantially adjacent to the working surface and a front surface with a plurality of lateral grooves for receiving the raised areas on the working surface such that movement of the platform toward the working surface into a working area adjacent the grinding wheel enables the raised areas to pass into the lateral grooves and grind the workpiece;

a first spindle and collet positioned in front of the working area for rotating the workpiece and for moving the workpiece one or both of forwardly and backwardly through the working area;

a second spindle and collet positioned behind the working area for rotating the workpiece and for moving the workpiece one or both of forwardly and backwardly through the working area.

106. A centerless grinder as in claim 105, further comprising a first pivot and a second pivot, and wherein the first spindle and collet is coupled to the platform through the first pivot to maintain alignment of the first spindle and collet with the platform during the movement of the platform toward the working surface and the second spindle and collet is coupled to the platform through the second pivot to maintain alignment of the second spindle and collet with the platform during the movement of the platform toward the working surface.

107. A centerless grinder as in claim 105, further comprising:

a first linear actuator for actuating the first spindle and collet;

a spool for holding wire stock;

a gripper for gripping the wire stock and dispensing a length of the wire stock from the spool through the first spindle and collet; and

a cutter for cutting the length of wire stock to provide the workpiece.

108. A centerless grinder as in claim 107, wherein the gripper comprises a set of pinch rollers.

109. A centerless grinder as in claim 107, wherein the gripper comprises an indexing gripper.

110. A centerless grinder as in claim 105, further comprising a feed screw and servomotor for moving the platform one or both of toward the working surface and away from the working surface.

111. A centerless grinder as in claim 105, further comprising a motor for spinning the first spindle and collet and a feed screw and servomotor for moving the first spindle and collet one or both of forwardly and backwardly through the working area.

112. A centerless grinder as in claim 105, further comprising a motor for spinning the second spindle and collet and a feed screw and servomotor for moving the second spindle and collet one or both of forwardly and backwardly through the working area.

113. A centerless grinder as in claim 107, further comprising a second linear actuator for actuating the second spindle and collet.

114. A centerless grinder as in claim 108, further comprising a motor for rotating the pinch rollers.

115. A centerless grinder as in claim 108, further comprising a first structure positioned between the pinch rollers and the spool having a first passageway for receiving the wire stock and guiding the wire stock through the pinch rollers.

116. A centerless grinder as in claim 115, further comprising a second structure positioned between the pinch rollers and the working area having a second passageway for receiving the wire stock and guiding the wire stock through the first spindle and collet.

117. A centerless grinder as in claim 116, further comprising a third structure positioned between the pinch rollers and the second structure having a third passageway for receiving the wire stock from the pinch rollers and guiding the wire stock toward the second passageway.

118. A centerless grinder as in claim 116, wherein the cutter comprises a knife blade positioned adjacent the outlet of the second passageway.

119. A method of grinding a workpiece using a centerless grinder, the centerless grinder comprising a grinding wheel, a support for holding the workpiece and moving the workpiece laterally toward the grinding wheel into a working area adjacent the grinding wheel for grinding the workpiece, a first spindle and collet positioned in front of the working area for rotating the workpiece and moving the workpiece one or both of forwardly and backwardly through the working area, and a second spindle and collet positioned behind the working area for rotating the workpiece and moving the workpiece one or both of forwardly and backwardly through the working area, the method comprising:

grinding one end of the workpiece using the first spindle and collet;

moving one or both of the first spindle and collet and the second spindle and collet such that the one end of the workpiece passes into the second spindle and collet;

opening the first collet to release the workpiece;

closing the second collet to grip the workpiece;
and

removing the workpiece from the working area using
the second spindle and collet.

120. The method of claim 119, further comprising
grinding the other end of the workpiece using the second
spindle and collet.